

THIS REPORT HAS BEEN DELIMITED
AND CLEARED FOR PUBLIC RELEASE
UNDER DOD DIRECTIVE 5200.20 AND
NO RESTRICTIONS ARE IMPOSED UPON
ITS USE AND DISCLOSURE.

DISTRIBUTION STATEMENT A

APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED.

UNCLASSIFIED

AD NUMBER: AD0312751

CLASSIFICATION CHANGES

TO: Unclassified

FROM: Confidential

LIMITATION CHANGES

TO:
Approved for public release; distribution is unlimited.

FROM:
Distribution authorized to U.S. Gov't. agencies and their contractors;
Administrative/Operational Use; 1 Jul 1959 Other requests shall be
referred to the Army Feltman Research and Engineering Lab, Picatinny
Arsenal, NJ 07806

AUTHORITY

ARRADCOM LTR, 13 FEB 1980

THIS PAGE IS UNCLASSIFIED

"NOTICE: When Government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the U.S. Government thereby incurs no responsibility, nor any obligation whatsoever, and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto."

6
CONFIDENTIAL

TECHNICAL MEMORANDUM REPORT ORDB-YES-9

**A PROPOSED ARMAMENT SYSTEM
FOR MEDIUM TANKS (U)**

**SIDNEY JACOBSON
ELIE L. BARRIERES**

FC

AUGUST 1959

FILE COPY

Return to

ASTIA

ARLINGTON HALL STATION

ARLINGTON 12, VIRGINIA

Attn: TISSS

ORDNANCE PROJECT NR. TW-426

DA PROJECT NR. SA04-01-001

UNIT A

ANTI-TANK AMMUNITION SECTION

ARTILLERY AMMUNITION LABORATORY

FELTMAN RESEARCH AND ENGINEERING LABORATORIES

PICATINNY ARSENAL

DOVER, NEW JERSEY

"This document contains information of the National Defense of the United States and its transmission or disclosure in any manner to an unauthorized person is prohibited by law."

ASTIA
001 12 339

CONFIDENTIAL

TIPDR

COPY NR. 15

CONFIDENTIAL

AD No. 344
ASTIA FILE COPY

CONFIDENTIAL

Technical Memorandum Report No. ORD38-TE3-

A PROPOSED ARMAMENT SYSTEM FOR MEDIUM TANKS (U)

by

Sidney Jacobson

Elie L. Barriores

July 1959

Feltman Research and Engineering Laboratories

Picatinny Arsenal

Dover, N. J.

Reviewed:

Earl H. Buchanan
Chief, Anti-Tank Ammo Sec.

Approved:

Paul Vogel
Acting Chief, Art Ammo Lab

CONFIDENTIAL

CONFIDENTIAL

TABLE OF CONTENTS

	<u>Page No.</u>
Objective	1
Summary.	1
Conclusions and Recommendations.	2
Introduction	3
Discussion	4
References	8
Figures 1 - 6.	9 - 14
Distribution List	15

CONFIDENTIAL


CONFIDENTIAL

OBJECTIVE

(C) The object of this study is to evaluate and propose a tank gun weapon system which exhibits significant improvement over the capabilities of the presently adopted 105mm, T254 Gun.

SUMMARY

(C) ✓ An armament system is described ~~in this report~~ which is designed to provide increased firepower for existing medium tanks and to provide a weapon system for future generation tanks. The system consists of a 105mm smoothbore gun designed to minimize turret intrusion and gun length. It fires a discarding sabot kinetic energy projectile capable of penetrating in excess of five (5) inches of armor plate at 60° obliquity at a range of 2000 yards or six (6) inches at 60° at ranges up to 500 yards. The ammunition complement of this system will include HEAT, HE and WP Cartridges.



CONFIDENTIAL

CONCLUSIONS AND RECOMMENDATIONS

- (C) 1. A tank gun-ammunition system is proposed which is superior in armor penetration capability to any existing tank gun system.
- (C) 2. The design of the gun provides for the smallest turret intrusion of any gun in the medium tank class and consequently permits a saving in turret size and weight.
- (C) 3. The proposed gun system is adaptable to the recently standardized M60 Tank offering increased weapon effectiveness.
- (C) 4. All ammunition types proposed are presently being test fired or were recently suspended while in an advanced state of development.
- (C) 5. It is recommended that a prototype gun be designed, fabricated and tested.
- (C) 6. It is recommended that further studies be undertaken by the responsible agencies to adapt the proposed system to existent or future generation tanks.

CONFIDENTIAL

INTRODUCTION

(C) 1. During October and November 1958, a series of exhaustive comparative tests were conducted at Aberdeen Proving Ground, Maryland for the purpose of determining the most suitable gun system for the XM-60 Tank. The result of these tests was a recommendation that "the 105mm, X15E8 Gun be considered the most suitable of the candidate types considered for the XM-60 Tank" (Ref. 1, Pg 37).

(C) The following gun-ammunition systems were evaluated in these comparative tests:

TABLE I

Armament Systems Evaluated at APG During Oct - Nov 1958

<u>Gun</u>		<u>Ammunition</u>	
<u>Caliber</u>	<u>Designation</u>	<u>Type</u>	<u>Designation</u>
120mm	M58	HEAT	T153E13
120mm	T123	HEAT	T153E13
120mm	M58	AP-T	M358E1
120mm	T123	AP-T	M358E1
105mm	X15E8	APDS-T	-
105mm	T254	APDS-T	-
90mm	T208E9	APFSDS-T	T320E82
90mm	M41	HEAT	T300E53

(C) 2. The smoothbore 90mm T208 Gun - T320 APFSDS "Arrow" system exhibited terminal ballistic characteristics superior to the recommended X15E8 Gun System, however other considerations such as the accuracy penalty incurred by the high gun wear rate weighed heavily against the choice of this system. It is the purpose of this report to present a gun system which fully exploits the armor defeating potential of the arrow-type smoothbore gun-projectile system, while eliminating its objectionable aspects.

CONFIDENTIAL

DISCUSSION

(C) 1. In light of the results of the comparative testing performed at Aberdeen Proving Ground, the need for an armament system which retains the good features of the 105mm, X15E8 Gun and yet is capable of defeating more armor is clearly evident. The system proposed in this report is designed to incorporate discarding sabot and HEAT ammunition of minimum size and weight for ease of handling and rapid loading to minimize time to hit. The gun for this system is designed to have a penetration capability greater than the recently adopted 105mm T254 Gun while the turret intrusion and consequent necessary size of turret is reduced. A comparison of the proposed system to various existing tank gun systems is shown in Table II.

TABLE II

Physical Characteristics of Various Medium Tank Gun Systems

<u>Designation</u>	<u>Caliber (mm)</u>	<u>Weight (lbs)</u>	<u>Length (ins)</u>	<u>C.G. from rear face of Breech (ins)</u>
XM- (proposed)	105	3012	233.2	49.0
T254E2 (U.S. version of X15E8)	105	2492	218.50	62.9
T210	105	4315	312.30	75.1
T208	90	3265	276.38	68.6
M41, M36	90	2650	192.4	55.5

(C) 2. The initial parameters to be fixed in the design of the gun were muzzle velocity and as-fired weight for the discarding sabot projectile. Various gun configurations yielding the aforementioned muzzle conditions were evaluated, using a Berkeley "Ease" analog computer to calculate Pressure vs. Travel and Velocity vs. Travel curves. The results of these calculations showed that in order to obtain a small chamber volume and thereby a small complete round, an increase in pressure above common values was indicated. A pressure of 61,000 psi (copper) was chosen as being the upper limit which can be withstood by the ammunition. This pressure yielded a chamber volume requirement of 625 cu. in. based on a loading density of .85 g/cc of M17 Propellant. The ballistic drawing of the final gun design is shown in Fig. 1. The overall length of the complete round (APFSDS Shot, Fig. 2) is approximately 41 inches for this chamber configuration.

CONFIDENTIAL

The gun design for this proposed system utilizes the autofrettage manufacturing technique and a gun steel with a 150,000 psi elastic limit to achieve a tube of minimum weight and size. A representative breech mechanism weight of 1200 lbs was chosen from various existing breech mechanisms of similar size.

(C) 3. The gun configuration which resulted from these calculations offers a number of advantages. Of primary importance is a penetration capability considerably better than any existing gun firing an APDS round. Second is the small turret intrusion made possible by a center of gravity location closer to the breech than any of the guns compared in Table II. Third, the detrimental effect of high erosion rates common to high velocity guns is reduced by autofrettage, which hardens the bore surface thereby reducing erosion, and by the elimination of the steep forcing cone which experienced the highest erosion rate in the smoothbore T208 and T210 Guns. Also, the delta-finned APFSDS Shot, described later in the report, is not sensitive to erosion, resulting in a considerably longer gun life than the smoothbore guns in which erosion was a serious problem.

(C) 4. The APFSDS round for this system (Fig. 3) is based on a projectile concept presently being tested in a supporting research project. This projectile has exhibited excellent potential in firing tests performed to date. The penetrator is essentially the same as that of the 90/40mm, T320 and the 105/40mm, T346 Arrow projectiles. But since the velocity regime of the proposed system is 100 fps higher than that of the 90mm Arrow round, penetration potential of the new round is estimated to be somewhat superior to that demonstrated by the latter.

(C) 5. This delta-finned round eliminates development problems of Arrow type ammunition in three major areas. The most important of these is the detrimental effect on accuracy incurred by the high wear rate of the T208 and T210 Guns. It has been established in firing tests of the Delta-finned shot that excellent obturation is obtained with this round even in tubes worn to a point where considerable loss in obturation is noted in an Arrow type round (Fig. 4). Therefore, even if a relatively high wear rate were still present in the proposed design, the effect of this wear would be reduced and the useful life of a gun tube increased considerably. No definite figure is available as to what gun life can be expected with this round; results of firings to date indicate that the life should be at least double that experienced with Arrow type projectiles.

(C) 6. The second of these areas is the problem of burning of the fins and consequent loss in accuracy experienced during the Arrow development program. The delta-fin design does not expose the fins to the high temperature propellant gases at any time as does the Arrow. Since obturation is at the pusher plate, the fin is protected from

CONFIDENTIAL

these hot gases. Also, a fin of the delta type is specifically designed for the hypersonic flight regime, and will not be materially affected by aerodynamic heating while in flight.

(C) 7. The third superior aspect of this new design is its low aerodynamic drag. The aerodynamic configuration of the projectile was designed to yield as low a drag coefficient as possible without sacrificing flight stability. The result of this low drag is a markedly reduced velocity fall-off rate and the ability to deliver to the target a higher percentage of the available muzzle energy than any other discarding sabot shot.

(C) 8. Using the existing penetration capabilities of the protection ballistic limits of the Arrow projectile as a basis for estimating the performance of the delta-fin shot, penetration of 5 inches of armor plate at 60° obliquity is predicted at a range of 2000 yards and 6 inches at 60° obliquity at a range of 500 yards. Defeat of the triple spaced Tripartite armor configuration is estimated to be marginal with the present penetrator configuration. However, a program has been initiated to develop a penetrator configuration capable of defeating triple spaced armor. This program is described in Paragraph 14.

(C) 9. Another of the major problem areas common to all hyper-velocity ammunition is that of determining the flight path of the round in the event of a target miss. This is accomplished in lower velocity ammunition by means of a pyrotechnic tracer installed in the base of the projectile. However, the use of a tracer for sensing a projectile having flight velocities in the neighborhood of 5000 ft./sec. becomes quite difficult due to the short time of flight. Adding to this problem is the obscuration of vision caused by the dust and smoke of the muzzle blast. This obscuration is of such a degree and duration that if a hit is not made on the target, there is little chance of sensing the round regardless of whether a tracer is employed or not. To eliminate this disadvantageous condition, it is proposed to incorporate a sensing system in the 105/40mm Delta-finned round which will leave a persistent trail capable of being observed from the tank after the obscuring smoke and dust has cleared.

(C) 10. A system of this nature is presently under study at Picatinny Arsenal. Sensing is provided by a smoke trail of sufficient density and persistence to make observance along the trail possible, while it will not be readily observable from some point to the side of the trail. A delay provision is to be incorporated in the round so that the trail will commence at a point some 400 or 500 yards from the gun muzzle, thereby reducing the ability of an observer to locate a tank firing from concealment.

(C) 11. The smoke generator will be installed in the hollow steel windshield of the projectile. (Fig. 5). It consists of a

CONFIDENTIAL

liquid which will provide smoke of the proper density when brought into contact with air at the high temperatures produced in flight due to the Mach number temperature rise. This liquid is metered through bleed holes at the base of the windshield, and is forced out of the windshield cavity by the pressure generated by allowing ram air into the front of the cavity through a hole in the nose. Provision will be made to prevent contact of the pressurizing air and the smoke producing liquid. Generation of gas inside the windshield cavity could result in splitting or bursting the windshield in flight. The delay provision could be accomplished by plugging the exit holes with a thermoplastic compound which will melt after being exposed to aerodynamic heating for a period of approximately a 1/4 second.

(C) 12. The HEAT round for this system is the cartridge presently under development for the 105MM Gun, T254, namely, Cartridge, HEAT, 105MM, T384 (Fig. 6). Although the T254 Gun is a rifled tube, firing of the T384 from a smoothbore tube would present no design problems because it is a fin stabilized configuration. This round is presently in the ED phase of development.

(C) 13. The HE and WP projectiles for this system are the Cartridges, 105MM, HEFS, T344 and 105MM, WPPS, T343 respectively. These were initially under development for the 105MM Smoothbore Gun T210, and although suspended, are in an advanced state of development.

(C) 14. To further develop the potential of the proposed system, the results of two programs now in progress can be integrated into the overall system. First of these is the combustible cartridge case, which would offer the advantages of a smaller and lighter complete round, no cartridge cases to dispose of and faster loading and handling. The second program is an investigation of armor penetrators being initiated on a scale-model basis in a light gas gun at Picatinny Arsenal. The aim of this investigation is to evolve superior armor penetrators for both single and spaced armor targets. A specific goal of this scale-model program is to develop a composite penetrator of high length-to-diameter ratio capable of penetrating a triple spaced-armor target such as specified in the Tripartite Agreements.

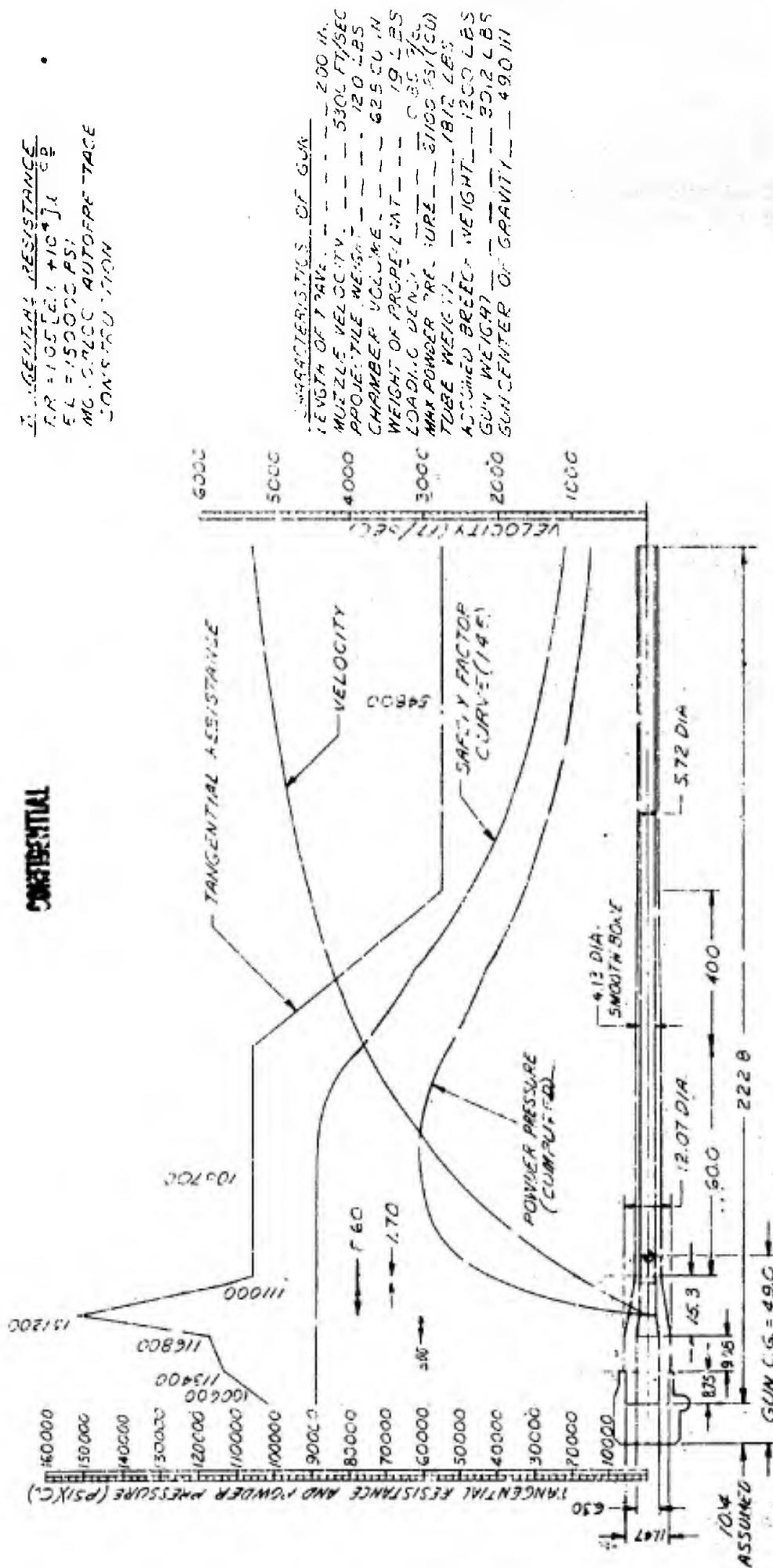
CONFIDENTIAL

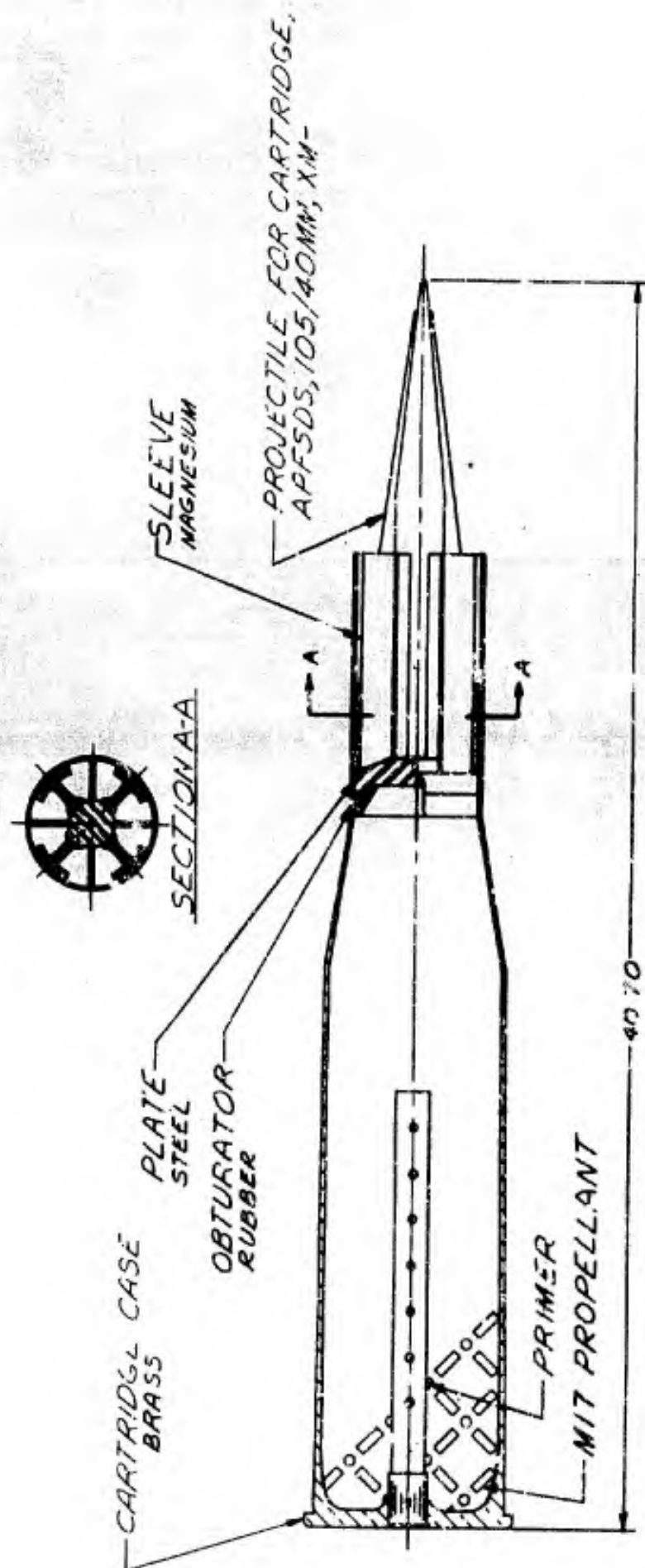
REFERENCES

1. "Report on AM60 Weapon System Evaluation" - First Report on Ordnance Project No. 91-419, Aberdeen Proving Ground, Maryland (Secret).

CONFIDENTIAL

CONFIDENTIAL



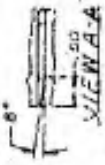


CARTRIDGE, APFSDS, 105/40MM, XM-1

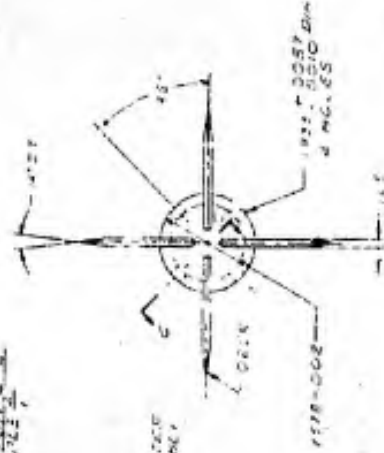
FIGURE 2

CONFIDENTIAL

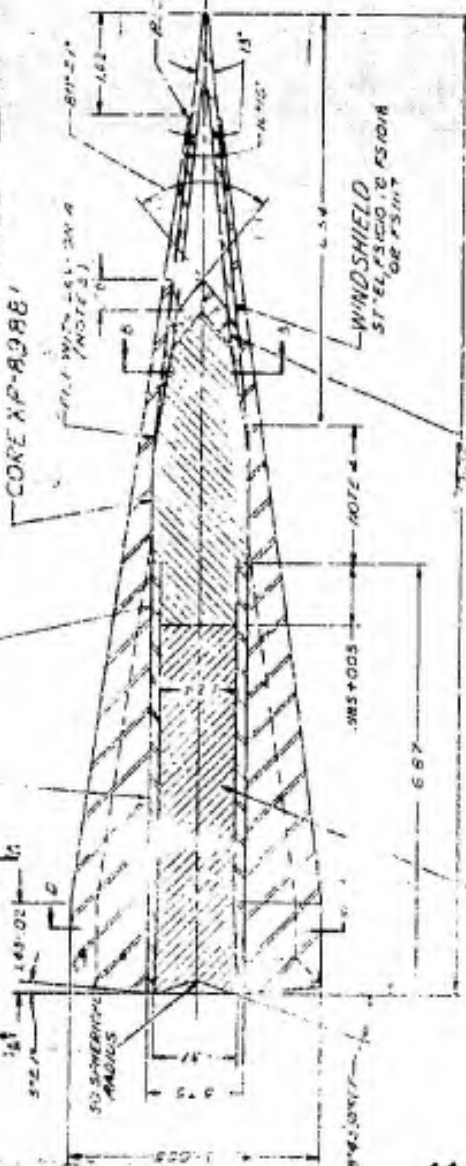
SLEEVE
STEEL, PSARG TO PS1040
NOTE 3



SECTION C-C
SCALE 1/2"



SECTION B-B



CAP
STEEL, PS1019, 1000 INCHES

BODY
STEEL, PS1017, 1000 INCHES

NOTE 1: THE 1000 INCHES IS THE TOTAL LENGTH OF THE PROJECTILE AT ANY TIME DURING THE LIFE OF THE PROJECTILE. THE 1000 INCHES IS THE TOTAL LENGTH OF THE PROJECTILE AT ANY TIME DURING THE LIFE OF THE PROJECTILE. THE 1000 INCHES IS THE TOTAL LENGTH OF THE PROJECTILE AT ANY TIME DURING THE LIFE OF THE PROJECTILE.

FIGURE 3
PROJECTILE CARTRIDGE,
105/40MM AP, SD5, XM-

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

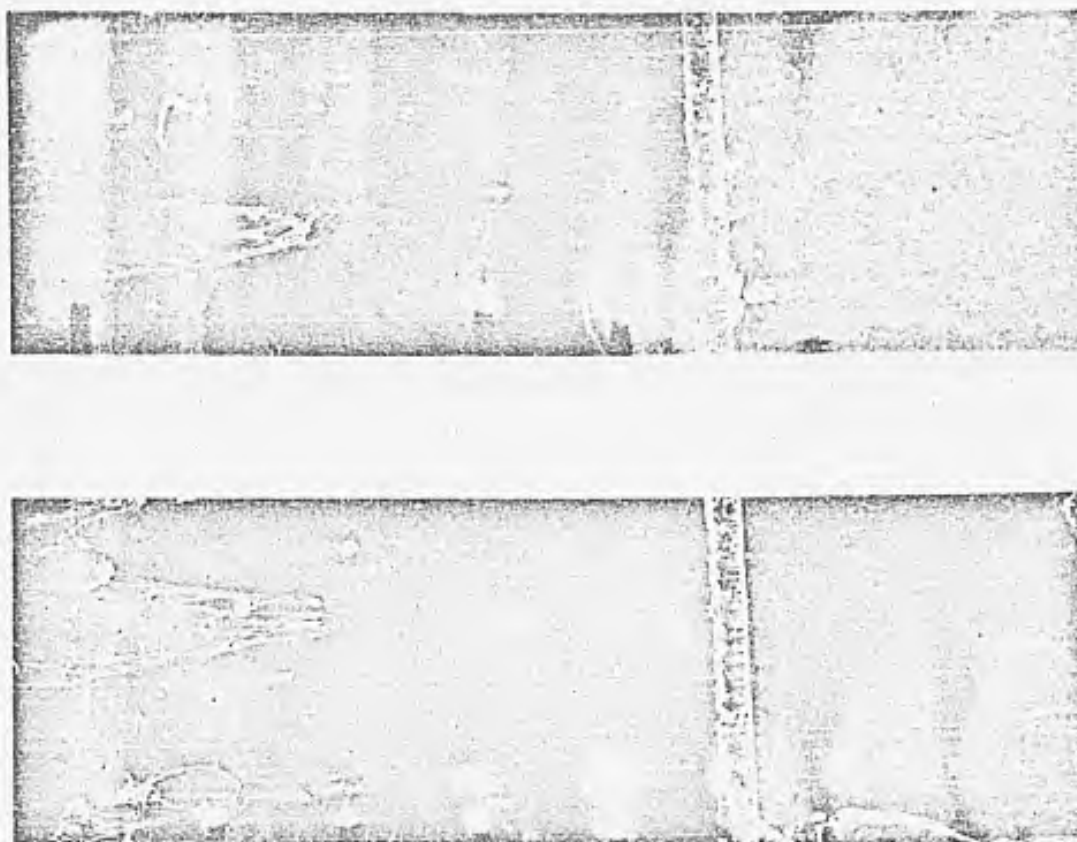


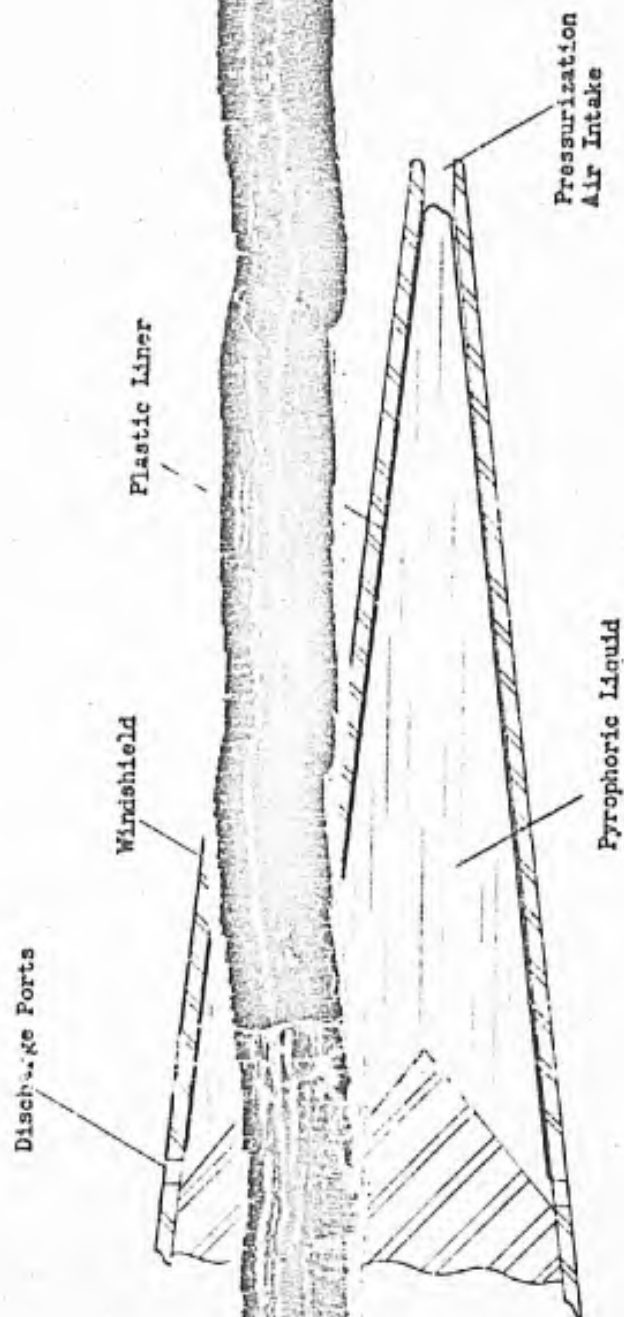
Figure 4

A comparison of Typical Obturation Characteristics between the 90MM Delta-Finned Round and the 50MM T320 Arrow Round.

TOP: Delta-Fin (Shot, FS, Model 2) T208E4 Tube, tube round #57. Note emergence of round before blast.

BOTTOM: Arrow (T320E76) tube round 56.

CONFIDENTIAL



Scale 1.5:1

Discharge and inlet ports are sealed with a thermoplastic material designed to melt under aerodynamic heating while in flight.

Figure 5
Installation of a Smoke Generator in the Windshield
of Projectile for Cartridge, 105/40mm, APFSAS, XM-

CONFIDENTIAL

CONFIDENTIAL



CONFIDENTIAL

CONFIDENTIAL

~~CONFIDENTIAL~~

AD

312751

FOR
MICRO-CAL
CONTROL

1

OF

1

Reproduced by

Armed Services Technical Information Agency

ARLINGTON HALL STATION; ARLINGTON 12 VIRGINIA

~~CONFIDENTIAL~~